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Case Report

# Tension wiring to increase stability of conventional plating for proximal humeral fractures: An alternative to a locking plate

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## Abstract

Fixation of comminuted or osteoporotic fractures in the proximal humerus is a challenge for orthopedic surgeons. In the past two decades, locking plates have been used for proximal humeral fracture fixation. However, complications such as loss of reduction have been reported, and the implants are not always available in some regions. Therefore, we describe an alternative procedure involving fixation with a nonlocking cloverleaf plate augmented with tension wiring to provide adequate stability and prevent loss of reduction.

**Keywords:** *Cloverleaf plate, Proximal humerus, Tension wire*

## Introduction

Attaining stable fixation is often difficult in complex proximal humeral fractures because of comminution and poor bone quality. Locking plates have recently been introduced for proximal humeral fracture fixation and have yielded favorable clinical outcomes. However, complications such as secondary loss of reduction, varus malalignment, and screw cuts have been reported [1-4]. In the past decades, cloverleaf plates have been commonly used for proximal humeral fracture fixation and have yielded favorable clinical results. However, biomechanical studies have revealed that cloverleaf plate fixation has inferior mechanical strength compared with locking plate fixation [5,6]. Tension wiring is a commonly used operative technique for internal fixation of fractures and may serve as an augmentation device on the fixation construct [7-9]. Therefore, we describe an alternative fixation procedure involving a cloverleaf plate augmented with tension wiring on the screws. The proposed procedure yielded superior stability and favorable clinical outcomes.

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## Case report

Between 2007 and 2009, the tension wiring and plating technique was performed in two men and three women (aged 54–71 years) with proximal humeral fractures [Table 1]. All fractures were classified as three-part fractures according to the Neer classification. Four were fresh cases and one patient received revisional osteosynthesis because of primary fixation failure [Figure 1].

### Surgical technique

The patients were seated in the beach chair position. The proximal humerus was exposed using the standard deltopectoral approach. The fracture site was irrigated, and the debris and hematoma were removed. The fracture was reduced through direct manipulation and leverage and temporarily fixed with multiple Kirschner

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**Table 1: Patient data and prognoses of the five cases**

| Case number | Age/gender | Involve side | Neer classification | Time to union (M) | Complications |
|---|---|---|---|---|---|
| 1 | 53/male | Right | 3 parts | 4 | - |
| 2 | 71/female | Right | 2 parts* | - | Implants irritation |
| 3 | 54/female | Right | 3 parts | 5 | Implants irritation |
| 4 | 70/female | Left | 3 parts | 5 | - |
| 5 | 69/male | Left | 3 parts | 4 | - |

*Case 2 received revisional osteosynthesis because of primary fixation failure and the breakage of implants. M: Month

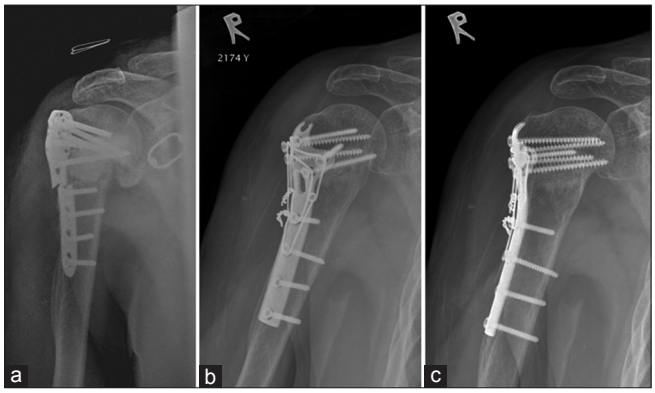


**Figure 1:** (a) Preoperative images of a 71-year-old woman with proximal humeral fracture. The initial locking proximal humerus plate failed; hence, the tension wiring and plating technique was used. (b and c) Radiographic evaluation reveals full healing of the fracture 3 years after surgery

wires. An artificial or allogenic bone graft was used to repair the metaphyseal bone defect. After acceptable fracture reduction was achieved, a 3.5 mm nonlocking cloverleaf plate was selected, and anatomical plate-based precontouring was performed by cutting the superior arm and bending the anterior and posterior arms [Figure 2a]. Screws superior and inferior to the ovoid screw hole were termed the head and shaft screws, respectively.

Subsequently, fixation was completed by inserting the screws into the plate. A stainless steel wire was placed before securing the screws. Two head screws in the bilateral arm and a shaft screw were tightened with the cerclage wire, creating a triangular loop [step 1, Figure 2a, arrow]. Another loop was created between one or two head screws and one shaft screw [step 2, Figure 2b]. After tightening the wires under tension, the screws were secured [Figure 3]. Fluoroscopy was performed to confirm fracture reduction.

The procedure was successful in all five cases and the fractures healed in all cases with no loss of reduction such as varus collapse. Two of those five patients underwent implant removal after 1–3 years because of implant irritation.

### Details of an interesting case

A 71-year-old woman presented to the orthopedic emergency room with right shoulder pain and disability after falling from stairs. Plain radiography revealed a fracture in the right proximal humerus, which was classified as a three-part fracture according to the Neer classification. Initial fixation was achieved using a locking proximal humeral plate (LPHP) (Synthes, Switzerland). However, the implant broke and loss of reduction was observed 2 months after surgery [Figure 1a]. Revisional osteosynthesis was recommended, but the patient could not afford another LPHP. Therefore, our alternative procedure involving fixation with a nonlocking cloverleaf plate augmented with tension wiring was applied.

The details of the surgical procedure are described previously. Postoperatively, a standard shoulder sling was used to protect the involved arm for 2 weeks; subsequently, an early rehabilitation program was initiated with active assisted range-of-motion exercises. This patient was then lost to follow-up at our clinic but returned 3 years after surgery. She complained of mild soreness when abducting her arm by more than 140° and asked for removal of the implants. Radiographic evaluation revealed full healing of the fracture [Figure 1b and c]. Therefore, the implants were removed, resulting in symptom relief.

## Discussion

Attaining stable fixation in proximal humeral fractures is often difficult because of comminution and poor bone quality. Numerous surgical techniques and devices have been proposed, such as percutaneous pin fixation, intramedullary nails, plates and screws, and locking plates. In recent years, the locking plate has been used to treat osteoporotic bone fractures. Biomechanical studies have revealed that the holding power of the humeral head of the locking plate is significantly higher than that of the nonlocking cloverleaf plate [5,6]. Recent studies have reported favorable functional outcomes after fixation with the proximal humeral locking plate. However, overall complication rates of up to 33% have been reported [1-4]. The use of the cloverleaf plate for open reduction and internal fixation is a suitable treatment option. Although more than half of patients exhibit favorable outcomes after cloverleaf plate fixation [10-12], some complications have been reported. Secondary varus displacement, varus malunion, and screw cuts are common.

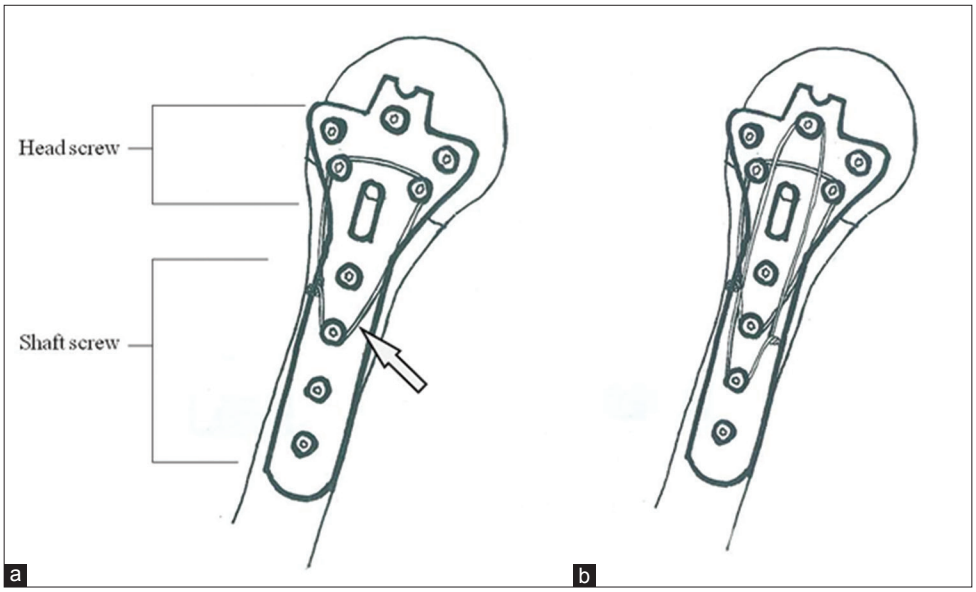


**Figure 2:** (a) Schematic of step 1. The stainless steel wire is tightened on a 3.5-mm, precontouring, nonlocking cloverleaf plate. (b) Step 2. Another loop is established between one or two head screws and one shaft screw

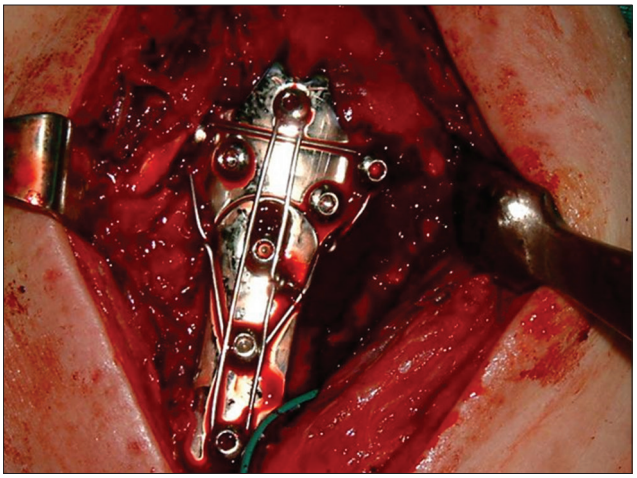

**Figure 3:** Intraoperative view of the tension wiring and plating technique

The rotator cuff force is a major factor contributing to varus displacement and loss of reduction [5]. When the shoulder is abducted to 60°, the rotator cuff force may reach 9.6 times the weight of the upper extremity [13]. To counteract the angular force in the proximal humerus, a metal and nonmetal suture technique was previously used [14,15]. Furthermore, the metal or nonmetal suture serves as an augmentation device on the fixation construct. Yildiz *et al*. [9] and Lu *et al*. [8] used a combination of two intramedullary pins and tension wires for fixation. Kim *et al*. [16] placed tension band sutures between the distal screw of an interlocking nail and the rotator cuff. Cornell [7] passed the tension wire beneath the supraspinatus tendon and distally beneath a nonlocking T-plate. Cheon *et al*. [17] suggested that using tension wire augmentation for plate fixation yields clinical outcomes identical to those obtained using the locking plate.

Therefore, we modified this tension wire augmentation technique by looping the tension wire between the head and shaft screws. In this device, the plate provides adequate stability to the fractures. The nonlocking screws facilitate the application of wires between the screws and the plate. The tension wire on the screw system, first described by French [18], has been used in corrective osteotomy of the cubitus varus. French [18] suggested that the screws tightened by the wire loop can provide a compressive force to counteract the varus force in the elbow. In our technique, looping of the screws by the tension wire could provide a compressive force to counteract the tension of the rotator cuff. We advocate this technique as an alternative to the proximal humeral locking plate because it can provide adequate stability.

One of the limitations of this technique is that it is an open procedure, which may increase the operation time and blood loss. Second, the node of the tension wire may cause soft-tissue irritation and is associated with a risk of neurovascular injury. Therefore, in this study, the node was bent and flattened on the plate [Figure 3].

In conclusion, we present a new fixation technique for proximal humeral fractures involving a combination of nonlocking cloverleaf plating and tension wiring. This fixation method can serve as an alternative to commercial locking implants, and the results are encouraging. Although the results of this new technique are promising, additional biomechanical studies and long-term follow-up are recommended.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

### Declaration of patient consent

The study was conducted in accordance with the Declaration of Helsinki and was approved by the local ethics committee of the institute (SCMH_IRB No: 1051003). Informed written consent was obtained from all patients prior to their enrollment in this study.

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